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of shifting cultivation in the area. In such a case reforestation would be assured by keeping fire out of the old clearings. This could be done by leaving relatively non-inflammable forest belts at least 60 feet wide between individual clearings. These forest belts would offer some protection against the spread of grass fires and at the same time would be a source of seed for further reforestation. Reforestation under such circumstances would be much easier and cheaper than if large contiguous areas were to be cleared and used.

Where natural reforestation is particularly slow, cultivators should be required to practice artificial reforestation. In scattered regions in Southeastern Asia tribesmen do this on their own initiative. Pendleton reports such a case in Burma.[35] Certain Dyak tribes in Borneo plant seeds of the candlenut tree (*Aleurites moluccana* Willd.) about 3 meters apart in a freshly cleared ladang before it has even been burned. In the eastern part of the Malay Archipelago shifting cultivators plant such trees as *Aleurites moluccana* Willd., *Erythrina lithosperma* Miq., *Albizzia falcata* Backer, *Hibiscus similis* Bl., *Casuarina equisetifolia* L., *Macaranga* species, *Euphorbia* species, *Sesbania grandiflora* Pers., and *Desmodium timoriense* DC. for the purpose of restoring the forest.

In Sumatra Deli tobacco planters initiated artificial reforestation after alang-alang had regularly invaded their fallow fields and caught fire so frequently that second-growth forest could not get a start. In Deli the tobacco fields are in use only 1 year and lie fallow 7 to 10 years. They should be protected by forest growth during that period. Therefore, in order to make this possible, the planters controlled fires by planting belts of teak along the highways and roads. These belts served as fireguards and at the same time provided lumber for tobacco-drying sheds. On the tobacco fields themselves they planted especially *Albizzia falcata* Backer, *Cassia siamea* Lam., *Pithecellobium saman* Benth., and *Leucaena glauca* Benth., which drive out the alang-alang[36] (Figs. 34–39).

Another way of speeding up reforestation is to spare a few of the larger trees at the time of the clearing. This is done by the Malays of Sumatra. They do not cut down *Koompassia parvifolia* Prain, *Arenga saccharifera* Labill., *Durio zibethinus* Murr. (durian), *Parkia* species, or *Garcinia grandifolia* Pierre.[37] The last three are fruit trees that are numerous in the forest, whereas the second is a palm whose flower stalk is tapped for its sugary sap and the first is preferred by bees as a hiving tree, which gives it its name, "bee-tree." This tree is preserved because the people want the honey. Worthington reports that in Africa "some tribes appear to realize the necessity of maintaining tree growth on their clearings and merely top the trees and lop the branches, so that the trees are enabled to

[35] Similar cases are known in the residency of Benkoelen in Sumatra, in central Celebes, and in Flores. See Hagreis: "Ladangbouw," 1930, p. 631.

[36] Jochems: "De begroeiing der tabakslanden," n.d., pp. 77–89.

[37] *Ibid.*, pp. 30–32.

[See p 40 ff, cat. 116 --Analyst]

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recuperate quickly when the area is again allowed to revert to bush."[38]

Several of the forest services of Southeastern Asia have made a rather successful use of the shifting cultivator in their endeavor to reforest the land. They have combined shifting culture and silviculture by hiring shifting cultivators to cut mature trees and to sow or plant new trees on cut-over or burned-over land. For this the cultivators are paid a small wage. In addition they are allowed to grow their own crops for one or two years between the rows of young trees. This system, known as the "taungya forestry system," was developed in 1856 by the German forester, Dietrich Brandis, while he was Superintendent of Forests in Pegu, Burma.[39] It is ingenious in that it recognizes the habits of the shifting cultivator and fits them into a modern forest economy instead of persecuting the cultivator and forcing him to give up his traditional culture. This system has been used in the teak forests of Java since 1871. The forest service makes a contract[40] with the peasants of Java according to which the peasants are to prepare the land and plant and take care of teak trees (*Tectona grandis* L.) in return for a small sum of money and the right to plant such crops as maize and red pepper (*Capsicum annuum* L.) between the rows of teak. The cultivation of upland rice is discouraged, and the planting of cassava, peanuts, castor beans, and tobacco usually is not allowed (Figs. 40, 41). [1]

The taungya forestry system is an excellent way of getting pure stands of commercial timber. The typical forest of the tropics is expensive to exploit because of the large variety of trees which it contains, many of which have little or no commercial value.[41]

As important as reforestation is soil erosion control. Where shifting cultivation is practiced in mountainous regions it often causes such acceleration in the rate of erosion that the rivers are choked with sediment and periodically do great flood damage. Flood control could be achieved in most cases by completely closing the headwaters and watershed areas to cultivators. On more gentle slopes the clearings should be rather narrow, should parallel the contours, and be separated by belts of forest. If at the same time the forest uphill were protected by fireguards, the clearings would have a chance to close quickly again so that the soil would be

[38] Worthington: Science in Africa, 1938, pp. 378–379.

[39] *Taungya* is the Burmese term for the temporary field of the shifting cultivator, a term that the foresters have adopted. E. P. Stebbing in his work, The Forests of India, Vol. 1, 1922, p. 376, writes:
"Brandis, moreover, recognized that the very system which, till then, had destroyed teak forests might be utilized to produce them, . . . and as early as 1856 an attempt was made in Prome district to sow teak in regular rows, together with the rice scattered by the toungya [*sic*] cutters. Twenty years afterwards this attempt had grown into a regular system, by which areas were being annually stocked with teak at a cost far below that of regular plantations." See also *Ibid.*, Vol. 3, 1926, pp. 415–428.

[40] Becking: "De djaticultuur op Java," 1928, pp. 50–52.

[41] Heske: "Der tropische Wald," 1939, p. 414. Heske's article gives an excellent short account of the forests of Southeastern Asia and points out that they are on the whole much easier to exploit than are the forests of tropical America because of the abundance of cheap labor.

[1] [See p 41, cat III — Burma]

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protected against abnormal erosion. Terracing would be the most effective method of checking soil erosion, but this requires a good deal of labor, which is scarce in areas of shifting cultivation.

The Forestry Service of the Indies started an interesting soil-erosion experiment near Tjiwidej in the mountains south of Bandoeng at an elevation of 1800 meters. Two adjacent parcels of forest land, lying on rather steep slopes, are drained separately—out of each parcel comes a little brook—and thus form separate drainage units. Both parcels were used by shifting cultivators who had cut and burned the forest. In one case the slope was left undisturbed; in the other the slope was terraced. At the foot of each slope catch basins were constructed to retain the sediment that was washed down by rain water and transported by the brooks. The amount of water that drains out of each unit was measured and the sediment weighed. The purpose of this experiment was to get quantitative measurements of the amount of erosion that is caused by shifting cultivation and to study the effect of terracing in reducing soil loss. During the first year both parcels lost very little soil, because the humus layer protected it; but in the second year the unterraced parcel lost 5.065 kg. of silt per square meter whereas the terraced parcel lost only one-half as much, or 2.524 kg.[42] (Figs. 42–45).

Under the conditions that we have discussed so far, no radical change in the system of cultivation is required. If, however, the population increases to such an extent that there is no longer enough available land to allow for a sufficiently long rotation cycle, more drastic remedies are necessary.

Such a situation arose in parts of the Outer Islands and attracted the attention of government specialists. Legal experts familiar with Indonesian customary law, foresters, and agricultural advisers collaborated to seek a solution.[43] Realizing that shifting cultivators are usually reluctant to give up their traditional form of land use, the specialists approached the ladang problem by searching for means of reforesting ladangs quickly. Experiments were made with the planting of quick-growing leguminous and non-leguminous trees, bushes, and shrubs to shorten the fallow period, restore the humus, protect the soil against accelerated erosion, eliminate the grasses, and, in the case of leguminous species, improve the soil by adding nitrogen.[44] We have already seen, however, that artificial refor-

[42] I was able to visit the Tjiwidej experiment with Mr. L. Gonggrijp, under whose supervision the work was carried out. For a detailed report on the project see Gonggrijp: "Het erosie-onderzoek," 1941, pp. 200–220.

[43] H. J. Friedericy of the Department of the Interior and H. Vonk and E. J. Wind of the Department of Economic Affairs, for example, worked together on the problem of ladang culture in the residency of Palembang.

[44] Experimental plantings included, among others, *Erythrina lithosperma* Miq., a light-loving tree which is typical in Southeastern Asia of dry, rather open climax forests and of second-growth forests; *Hibiscus tiliaceus* L.; *Albizzia falcata* Backer, one of the fastest-growing trees of Southeastern Asia, used widely as a shade tree on coffee plantations; *Aleurites moluccana* Willd., a tree at home in the drier parts of the East Indies; *Leucaena glauca* Benth.; *Pterocarpus indicus* Willd., a large tree frequently used along roadsides as

1 [see p. 42, category 16 -- Analyst]

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estation is not a discovery of Western-trained scientists but has long been practiced by certain groups in Southeastern Asia. It was the plan of the government to spread and enforce this practice of artificial reforestation wherever advisable. This practice, whereby the cultivator determines the vegetative cover during the fallow period instead of abandoning the ladang to chance growth, brings him to a transition stage between shifting cultivation and permanent cultivation. From there the step to permanent cultivation with crop rotation is but a short one.

Permanent cultivation requires repeated tilling and therefore more labor and tools than the shifting cultivator is accustomed to. Work animals are also desirable. An important obstacle to intensification of agriculture in wide areas of Southeastern Asia, however, is the fact that hill and mountain regions [up to about 1500 meters in elevation] are frequently infested with malaria so that the energy of the people is greatly reduced.[45] Moreover, the acquisition of such implements as plows, harrows, and hoes, and especially of work animals, calls for financial resources or credit, both of which the average shifting cultivator lacks. Some shifting cultivators do own livestock, such as cattle or carabaos, but utilize neither their labor nor their manure. Groups of the Mois in the mountains of Annam have carabaos, but they do not use the animals in their agricultural activities because they "cannot talk" to them.[46] On the Lesser Sunda Islands livestock is kept because it gives social prestige to the owner. Overstocking of the pasture areas on these islands has led to overgrazing and has cut into the forest area until there has developed a scarcity of land suitable for ladang cultivation. The same has happened in large areas in Africa. There it has been necessary to teach the native peasant the use of cattle and make him familiar with the plow. This was done successfully in northern Nigeria by combining the animal husbandry of the nomadic Fulani with the indigenous shifting cultivation of the Hausa peasant, thus developing "a system of permanent farming whereby a man with cattle of his own, say two working oxen and a few cows, can plough and maintain in fertility an area of land sufficient to supply all the requirements of himself and his family, and to obtain a surplus balance as a return for his labour. . . . Thus mixed farming represents a gradual evolution from the shifting methods of cultivation to a static type of agriculture, by the introduction of animal husbandry, and with the use of animal cultivation."[47] Above all, the peasant learns to preserve the animal manure and

a shade tree; *Dolichos lablab* L., a climbing herb which is valuable as a vegetable; *Crotolaria anagyroides* H.B. and K., a bush of vigorous growth which attains a height of from 12 to 14 feet and forms an excellent green manure; *Tephrosia candida* DC. and *Tephrosia vogelii* Hook., low shrubs useful as green manures; and *Mimosa invisa* Mart., a leguminous creeper which suppresses grasses.

45 Gourou: L'utilisation du sol, 1940, pp. 181 and 350.

46 *Ibid.*, p. 354.

47 King: "Mixed Farming in Northern Nigeria," 1939, p. 271. See also Faulkner and Mackie: West African Agriculture, 1933; and by the same authors: "The Introduction of Mixed Farming in Northern Nigeria," 1936, pp. 89–96.

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who does not know where he will be the next year cannot be expected to plant fruit trees. Under these conditions the diet is reduced to the simplest foods and is usually deficient.

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Zimmerman criticizes some of the characteristics of garden culture in the Thai part of the Malay Peninsula. The improvements that he recommends show that he has approached the gardens with a Western eye, looking for fruit trees "in rows at proper spaces, not scattered as is the case now." [6] He notices lack of tilling, an observation that could be duplicated in every country of Southeastern Asia. As a matter of fact, it is fortunate that the gardens—especially those that have many fruit trees and palms—are not clean-cultivated; otherwise erosion would have caused the same damage here that it has caused in the Westerners' rubber, tea, and coffee plantations—these were planted in rows and kept clean until the discovery was made that soil erosion is extremely severe under such conditions. Pendleton remarks:

> The average Occidental, accustomed as he is to clean cultivated orchards and vineyards in temperate zones, is inclined to keep a plantation in the tropics likewise cultivated. This is now quite generally recognized as a mistake. . . . Near Songkla [in southern Thailand] . . . are considerable plantings of fruit trees, planted as if they were forest trees. . . . Annually, before harvesting the fruit, the undergrowth is slashed and left on the ground, but there is no stirring of the soil or other cultivation. The results are excellent, and there is no soil deterioration, no catastrophic erosion, no expense for cultivation.[7]

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There is little literature on the importance of garden culture among the Malays of British Malaya. According to Grist,

> fruit cultivation is of little more than local importance. The total area under fruit, other than pineapples, is estimated to be 63,000 acres. . . . This area does not take into account the numerous small compounds surrounding Malay homesteads, in which a few fruit trees are planted and which, in the aggregate, must amount to a very considerable area. Although certain fruits acquire a reputation in particular localities, the distribution of the fruits is scattered throughout the country. For instance, North Johore is noted for its durians, Malacca for dukus [*Lansium domesticum* Jack], Penang for rambutans, but in point of fact, equally good quality fruit of these kinds can be found in other areas.[8]

Malaya lacks the detailed information about gardens and their economic importance that is found in Java, for instance, where the garden area of each village is known, because in Malaya there is no population pressure and therefore no need for exact field studies and careful inventories of the source of food supply.

The Philippines are like Malaya in respect to garden culture. Some districts around Manila Bay have specialized in such fruits as mangoes,

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[6] *Ibid.*, p. 163.
[7] Pendleton: "Some Interrelations," 1939, p. 50.
[8] Grist: An Outline of Malayan Agriculture, 1936, p. 228.

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lanzones, papayas, and chicos, which find a good market in Manila, but on the whole we rarely meet in the Philippines such intensive garden culture as in Java. The diet of the average Filipino is not well balanced and is particularly deficient in fruits and vegetables. In recognition of this fact the Bureau of Education and the Bureau of Plant Industry have both done much to impress the peasants with the need for fruit and vegetable gardens. Although the situation has improved during the past forty years and a large variety of fruits is now produced, the country still depends upon imports, whereas with a little effort most of the imported fruits could be produced locally and would furnish an additional source of income. It would be well to encourage the peasants to grow more fruits and to advise them on the most suitable varieties. In the other countries of Southeastern Asia, also, with the possible exception of Java, such advice would be valuable.

The published material available on the importance of gardens in Indochina is similarly limited in quantity. Even Gourou in his study of land utilization restricts himself chiefly to listing the fruits and vegetables found in the gardens and to stating that certain districts are renowned for the quality of their garden fruits. Gourou's list of fruits and vegetables is as varied and extensive, however, as similar lists for any of the other countries of Southeastern Asia.

Wet Fields

Throughout the countries bordering the South China Sea most of the cultivated land is used for the growing of lowland, or wet, rice. For this purpose the fields must be leveled and surrounded by earth dams to impound rain water during the rainy season or to confine the water that is carried to the fields through irrigation canals or lifted to the fields by mechanical means. If a field is properly leveled the surrounding dyke will keep the water everywhere at the same depth. The size of the wet-rice, or paddy, fields, and the amount of labor that is required to make them, depend upon the topography of the region. In the lowlands, where no terracing is required, there is relatively little labor involved in the making of paddies, which are frequently large. A hilly, or mountainous, terrain necessitates terracing, which demands greater effort and reduces the size of individual fields; the steeper the slope, the narrower the paddies. We have only to see the rice terraces of the mountains of northern Luzon, southern Bali, the Preanger districts of West Java, or Sumatra's West Coast in order to realize how much effort has been expended in building these terraces and how much energy must be devoted to their upkeep. The terraces, as well as the wet-rice fields of the plains, represent the accumulated efforts of generations of peasants, each of which has helped to extend the area devoted to the cultivation of wet rice (Figs. 50–58).[1]

Not all people show the same skill in the making of paddies. According to Credner, the Thai are quite helpless on sloping land that requires terracing before wet rice may be planted. They would prefer to migrate to a

[1] [See pp. 115 ff. Cato gory 116. -- Analyst]

243 small-scale water-control methods had in fact existed in this region before; the earlier technological interest was to expand rice production by increased water-control on specially fertile, generally volcanic, upland soils. The objective then and now was the same—to cultivate the most fertile areas; the difference was that the volcanic soils attracted local attention and were within the capacity of local people, considerably earlier than the deltaic soils.

[439] SOUTHEAST ASIA RICE EXPORTS AND IMPORTS
(million metric tons clean)

	Exporters			*Importers*		
	Burma	*Indochina*	*Siam*	*East Indies*	*Malaya*	*Philippines*
1915	2.12	1.09	1.0	.55	—	.22
1920	2.0	1.09	.25	.22	—	.07
1925	3.32	1.33	1.18	.50	.41	.10
1930	2.95	1.02	.93	.62	.60	.01
1935	2.93	1.52	1.38	.36	.48	nil
1940	2.50	1.40	2.00	.06	.70	.1
1950	1.17	.09	1.48	.28	.50	.16

A further process at work has been a decline in Southeast Asia consumption of rice per person over the last 30 years, which made possible the expanding exports of rice at a time when population was rapidly increasing. The declining consumption seems to be due to slight changes in diet habit; maize, potatoes and tapioca have steadily entered into local meals and the proportion of vegetables has increased, more especially as it has come to be realised that the dietetic value of meals exclusively based on rice, the custom in Southeast Asia for a long time, is low, as indicated by the small stature and delicate bones of Southeast Asia peoples.

245 Commercial agriculture has largely revolved round tree cultivation (arboriculture rather than agriculture) in which the continuous growing period produces maximum effects. In this tendency may be seen a return to the tree vegetation which is indigenous to equatorial Southeast Asia, and away from the annual and deciduous plants more suited to ecologies associated with the seasonal margins of the tropics. Labour difficulties too are eased to some extent by tree crops whose periodicity is better spread than in the case of annual crops. To the labour difficulty also is due the trend towards devolving arboriculture from plantation systems

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to smallholder systems, leading to the smallholder becoming an exponent of diversified rather than single crop cultivation.

While the region has sought to escape the consequence of overmuch dependence on one or two cash crops, Southeast Asia subsistence farming is really already highly diversified. Moreover, the region as a whole must be considered reasonably well diversified in the range of commercial crops it produces, even though individual districts within Southeast Asia are monocultivated rather than polycultivated.

Effects of the Second World War

During the 1941–42 campaign, battles were fought through Burma, Malaya and the Philippines. More military action took place in Burma and the Philippines over the year 1944–45. The direct long-term effects of these campaigns were not emphatic because agriculture and arboriculture cannot be "scorched" and denied to the enemy on a large scale. The war in these territories devastated internal communications, broke down the systems of internal trade, removed the means of communication between different parts of Southeast Asia and destroyed the channels to those overseas markets which had been the principal destination of commercial agricultural produce. Breakdown of external trade channels occurred in all Southeast Asia territories whether campaigns took place in them or not.

The first consequences of this disruption, as distinct from destruction, were to place a premium on subsistence farming, to cause all commercial cultivation to fall into desuetude, to undermine confidence in agriculture for cash, to cause the loss or destruction of draught cattle which were taken away for military use, to disperse labour forces, and to stimulate self-sufficiency policies. Very little of the perennial tree acreage, such as of rubber, was cut down—only 6 per cent in the case of Malayan rubber—yet it was the commercial production which suffered most from disruption, which created in the postwar period considerable difficulties for those territories needing imported rice for the labour to rehabilitate commercial farming and industries. Agriculture itself, where labour was available, rehabilitated quickly; all but 2 per cent of Malayan rice acreages were back in cultivation during 1945–46 and rubber made an equally quick comeback, so